## EXPOSED STEEL TEMPERATURES IN THE TROPICS.

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A series of observations was made at Balboa Heights, Canal Zone, during the month of April to determine the maximum heating of steel or iron exposed to the sun's rays in the Tropics.

*Method of exposure.*—Blocks of steel 2 by 2 by 12 inches were exposed to the sun's rays in a manner favorable for maximum heating. These blocks were placed across a 1 by 4 inch plank lying flat on a concrete pavement inside the instrument inclosure (fence). An 8 or 10 inch board was stood up edgewise a few inches from the blocks on the windward side to protect them from the wind movement, which was at all times very light immediately above the surface of the ground inside the fenced inclosure. The protection from wind movement obtained was not complete, but it was nearly so. It was thought to represent approximately the exposure found in the more protected sections of steel structures exposed to solar radiation.

The observations were made during the latter part of April with the midday sun directly overhead and its rays falling vertically on the earth's surface. A one-half inch hole was drilled into the center of each steel block. The resulting well was filled with mercury and readings were made at 15 minute or half hour intervals by immersing the thermometer bulb in the mercury well.

*Records.*—The highest steel temperature observed was 133 degrees F. at 3:30 p. m. April 26th. It is estimated that under the most favorable natural conditions possible in the Canal Zone the maximum temperature of exposed steel is not likely to exceed 140 degrees F.

Similar records of the temperature of exposed steel at stations in the United States or elsewhere are not at hand. It is thought, however, that the maximum temperature of exposed steel is higher in the Canal Zone than in the more humid sections of the United States, but lower than in the dry sections of the West and Southwest, as humidity in the atmosphere absorbs a considerable percentage of the sun's heat and diminishes the solar radiation reaching the earth's surface. It is estimated that the maximum exposed steel temperatures in the deserts of the Southwest may reach 160 degrees F. or higher. If not already available, it is suggested that it might be well to obtain a series of exposed steel temperature records at a few selected stations in different sections of the United States. These data would be of value to structural-steel engineers and designers who must figure the expansion and contraction of steel, covering the expected maximum range in temperature.

The following may be mentioned, illustrating the effects of temperature changes on steel structures of precise dimensions:

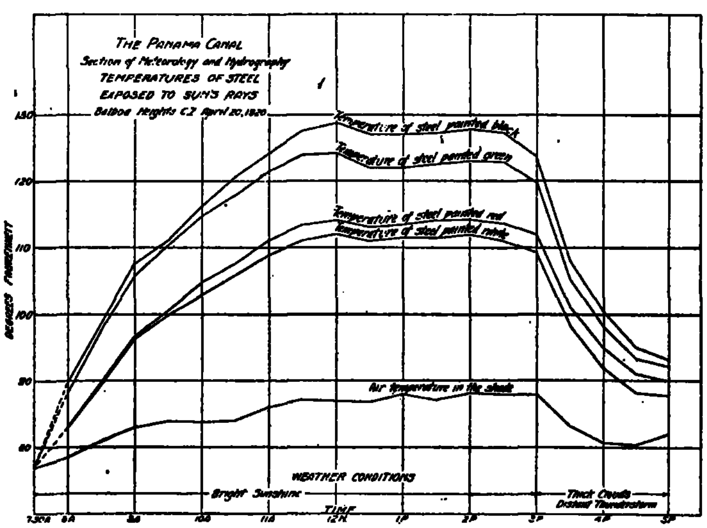
The steel spillway gates of the Panama Canal were designed to be as nearly water-tight as possible, and the leakage through them is very small. In measuring this leakage it was found to vary somewhat throughout the day, being regularly heavier during the daytime than at night, due to the action of the sun shining on one side of the gates and causing the metal on the exposed side to expand and the gates to buckle or warp slightly, thereby increasing the leakage.

*Influence of colors on exposed temperatures.*—Experimental observations were made to determine roughly the comparative heat absorbing properties of various colors exposed to the sun's rays. Blocks of steel of similar size and shape painted black, white, red, and green were exposed side by side.

Regarding the composition of the paint used it, was realized that it would be best to use paint of identical composition, except for the coloring pigment, but we had no equipment for mixing paints and were unable to do this. The paint used was obtained from the paint shop. I think its ingredients were linseed oil and ground white lead for the green, white, and red paint, plus the coloring pigments in the green and red paint. I am not sure regarding the black paint, but I think some other element was used instead of linseed oil, as it dried rapidly. The luster seemed very much the same in the various paints, which would seem important in the question of absorption.

The results obtained were not thought to be exact, but only approximate. It is probable that repeating the observations would not give precisely the same records, but very similar ones. Records made two years earlier with the same black and white blocks, but different coats of paint, were similar, but they showed a somewhat larger "spread" between the black and white steel temperatures, but the exposure was slightly different, both blocks lying flat on the concrete inside a skeleton or bottomless box.

Successive temperatures of each throughout the day are shown on the attached diagram (fig. 1).




Of the various colors black is known to absorb the maximum percentage of solar radiation and white absorbs the minimum per cent. It will be seen that colors have a very pronounced effect on the temperature of bodies exposed to direct solar radiation. A maximum "spread" of 20 degrees F. between the black and white steel temperatures was observed on one occasion. The red steel temperatures are only slightly higher than the white, indicating that red is not the warm color that it is popularly believed to be. On the other hand, green seems to absorb nearly as much heat as black.[1]

Experiments with cloth of different colors gave similar results, indicating that in hot weather one's comfort may be promoted by selecting wearing apparel of colors that have low heat-absorbing properties.

[1] Cf. experiments cited by Dorno, MONTHLY WEATHER REVIEW, June, 1920, 48: 351.

The results obtained in these observations are thought to be only roughly comparable, since varying atmospheric and other conditions may affect the readings, such as wind movement, humidity, intensity of solar radiation, composition of coloring matter, etc.

## DIURNAL PRESSURE CHANGE IN GULF OF FONSECA.

Capt. E. S. Jackson, commanding officer of the U. S. S. *Tacoma,* recently reported through the Hydrographic Office what he considered to be an instance of unusual diurnal pressure change. During the period from January 29 to February 29, 1920, while the *Tacoma* was stationed at Amalpa, Honduras, Gulf of Fonseca, Capt. Jackson observed daily between the hours of 12 noon and 1 p. m. a very sharp fall in the barograph trace. The average drop for an 8-day period, from January 29 to February 4, inclusive, during which the fall was most pronounced, was slightly more than 0.05 inch. There was no accompanying noticeable weather change.

Central America is on the northern edge of the area of greatest diurnal pressure variation in the Western Hemisphere, an area which, roughly, embraces Central America and the north-central portions of South America. As an example of the change that may occur in this region it is noted that at Mexico City the average diurnal fall in pressure from noon to 1 p. m. is about 0.04 inch.

The hourly rate of fall is, however, considerably less than that observed by Capt. Jackson for the hour 12–1 p. m., although the average total fall for all the afternoon hours is fully as much.

The barometric trace from the Weather Bureau station at Swan Island, off the northern coast of Honduras, the nearest point from which such a record is available, shows no unusual characteristics for the period in question.

Capt. Jackson has promised a further report to be made from La Union, Salvador, also in the Gulf of Fonseca.

## THE CLIMATE OF JAPAN AND FORMOSA.

By ELLEN MARY SANDERS.[1]

The climate of the festoon of islands which begins in the south with Formosa near latitude 21° N., and stretches northward to Yezo near latitude 46° N., is exceptionally interesting, not only as illustrating the change of climate which naturally comes about with such a change of latitude, but because it presents so great a contrast to the other countries bordering the oceans lying in the same latitude. A large body of data is now available, since the Central Meteorological Observatory of Tokio has been at work for over thirty years observing and collecting the results of other observers, and the observatories of Formosa have been working for close upon twenty years, so that a more detailed description of the climate of Japan and Formosa is possible than has as yet been given. Such a description is the aim of the present article. It can only be regarded as tentative, liable to modification when further data are forthcoming.

No description of the climate of Japan would be complete which did not emphasize the influence of the continent of Asia. Therefore, at the risk of repeating what is already well known an introductory account of the general results of the position of the islands is included. This is followed by a consideration as to the effects of ocean currents, and an account of the storms to which the islands are subject, on both of which topics new material is available. After these general considerations a detailed description of the climatic zones is given, based on the reports of the observatories of Japan and Formosa.

*General results of position.*[2]—Japan is situated off the east coast of Asia, so that during the cold season it has an immense stretch of frozen land to windward, and as a result its temperature is far colder than is normal for its latitude. In addition to the modification in temperature the distribution of rainfall is also a result of the proximity of the great land mass.

In winter the central part of Asia becomes an area of high pressure since the land cools more quickly than the water, therefore the winds blow out from the center. Fig. 1 shows the winter winds of Japan and Formosa. Japan comes into the track of those winds which blow from the NW. coming across the cold lands of northern Asia. To these winds the north coast of Japan owes its rain, and the cold winter, particularly marked in the island of Yezo. Formosa, on the other hand, comes into the zone of the NE. Trade Winds during its cool season, and thus has winds coming over the ocean from a northeasterly direction.

In summer the central part of Asia becomes an area of low pressure, due to the heating of the land mass, and consequently winds blow in toward the center from all sides. Fig. 2 shows the direction of such of these winds as cross Japan. It will be noticed that they blow from the SE. and that they traverse the ocean before reaching Japan, thus they are warm, moisture-laden winds. To these winds the southern coast of Japan owes the greater part of its rain, while Formosa, which lies far enough to the south to get the full force of the Monsoon, shares with China one of the heaviest rainfalls of the entire globe.

*Ocean currents.*—It was formerly thought that the ocean currents which flow in the adjoining seas were one of the most important factors of the climate of Japan. Recent investigations have led to a modification of this view. Therefore it is necessary to examine the effects of the ocean currents on the climate.

There are two warm ocean currents, the Tsushima and the Kuroshio, and one cold current, the Oyashio. The warm current, called the Tsushima, enters the sea of Japan through the strait of Korea and touches the northwest coast of Nippon.[3] The curve of the isotherms on the west coast of Japan, which may be seen in Fig. 7, is perhaps due in part to this current, although, in the main, the relief is responsible for the course of the isotherms. A large amount of the fog and rain which comes to the west coast during the winter may also be due in part to this current, since in winter the prevailing wind comes straight from the part of the ocean which is warmed by it.

The cold current, called the Oyashio, flowing in a southwesterly direction, touches the eastern and southern coasts of Hakodate and also eastern Nippon, and may contribute toward lowering the temperature of these districts. The other warm current, the Kuroshio, which touches the southern coast of Nippon in its course toward the northeast, is far more powerful than either of the others, and higher in temperature than the Tsushima. The great amount of rain on the southeastern coast of Japan during the summer may be partly due to this current.

[1] B. A. London and Bristol, England: Docteur de l'Univ. de Paris, France; British scholar, Bryn Mawr, U. S. A.
[2] Atlas of Meteorology. Bartholomew and Herbertson, (a) Plate 14 Pressure.
[3] Art. 4, Vol. XXXVII, Journal of Coll. of Sc. Imperial Univ. of Tokio.